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Short Communications

The role of ant nests in European ground squirrel's (*Spermophilus citellus*) post-reintroduction adaptation in two Bulgarian mountains

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Abstract

The European ground squirrel (*Spermophilus citellus*) is a vulnerable species, whose populations are declining throughout its entire range in Central and South-Eastern Europe. To a great extent, its conservation depends on habitat restoration, maintenance and protection. In order to improve the conservation status of the species, reintroductions are increasingly applied. Therefore, researchers focus their attention on factors that facilitate these activities and contribute to their success. In addition to the well-known factors like grass height and exposition, others, related to the underground characteristics, are more difficult to evaluate. The presence of other digging species could help this evaluation. Here, we present two reintroduced ground squirrel colonies, where the vast majority of the burrows are located in the base of anthills, mainly of yellow meadow ant (*Lasius flavus*). This interspecies relationship offers numerous advantages for the ground squirrel and is mostly neutral for the ants. The benefits for the ground squirrel, including reduced energy demand for digging, as well as additional surveillance and hiding places available, could greatly enhance the post-reintroduction adaptation process.

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Keywords

anthills, *Lasius flavus*, mountain, reintroduction, *Spermophilus citellus*, symbiosis

Introduction

The European ground squirrel or the souslik (*Spermophilus citellus*), is a rodent inhabiting pastures and meadows in Central and South-Eastern Europe. It constructs complex burrows up to 2 m deep (Brinkmann 1951, Ruzič 1978) where it hides, rests, reproduces and hibernates. During the last decades, the souslik's populations throughout its entire range are declining mainly because of habitat destruction and degradation (Coroiu et al. 2008). Currently it is listed as “Vulnerable” in the IUCN Red List and conservation measures have been taken all over its range. They often include conservation reintroductions – reestablishing the species in places where it was extinct. Most of the ground squirrel reintroductions in Bulgaria were organised by nature parks directorates and implemented in the mountains (Koshev et al. 2019).

Playing a key role in the ecosystem, the souslik lives in close interaction with several invertebrate species inhabiting its burrows - scarabid beetles (Carpaneto et al. 2011) and ectoparasites such as ticks (Honzakova et al. 1980) and fleas (Ryba et al. 1980). Some of these relationships are highly specific and not always reappear after reintroduction (Lindtner et al. 2019). Shabanova et al. (2014) also reported ants, as well as digger wasps and beetles, using sousliks’ burrows. The possible symbiosis with ants is especially interesting as they are also key ecosystem species, soil engineers and dominate in almost every terrestrial habitat. They may change the landscape by creating networks of soil macropores and building stationary, perennial mounds with altered physico-chemical structure and change the availability of resources for plants and animals (Alonso 2000, Ehrle et al. 2017). The nest’s structure (tunnels and chambers) allows water and gas circulation (Folgarait 1998). All these characteristics could be beneficial for the ground squirrels and possibly be linked to the conservation practice. Hapl et al. (2006) mentioned that the mounds of *Lasius flavus* could be used for initial hiding places in Slovakia for disorientated reintroduced sousliks, but the authors did not provide any references or further explanations.

Interactions between ants and small mammals, such as rodents and shrews, have rarely been documented (Panteleeva et al. 2016, Gilev and Nakonechny 2010, Scherba 1965, Mironov 1986). Often they concern the competition between ants and rodents for seeds (e.g. Brown et al. 1979). Vygonyailova (2011) reports the superficial and surrounding mound’s material of red wood ants is attractive food for rodents, possibly because of the higher organic components.

Taking into account these scare data, our goal is to report a confirmed case of an interspecific relationship between souslik and ants and to discuss its implications in the conservation reintroduction practice.

Materials and methods

Reintroduced colonies of ground squirrel in Bulgaria are regularly monitored. In 2017, it was observed that the majority of the holes were located in the base of anthills in two of these colonies (20.06.2017 in Bulgarka Nature Park and 30.06.2017 in Vrachanski Balkan Nature Park). The observations were confirmed in June 2018. On 11.06.2019 (Bulgarka Nature Park) and on 29.05.2019 (Vrachanski Balkan Nature Parka), the colonies were investigated in detail – multiple transects were designed in order to count and map the burrows and determine what percentage of them is associated with ant nests. The transects were chosen randomly, aiming to cover the entire area of the colonies (Suppl. materials 1, 2). When no more burrows were found, the transect was finished. Both holes of *S. citellus* and *Microtus* sp. were observed (identification based on holes' size and size and the surrounding excrement) but only the first type was considered in the current study. Each ant nest with a burrow was investigated - a small hole was made at the nest's top and 3 to 5 ants were taken, fixed in 75% alcohol and identified under a microscope. The walls of the burrow at the entry hole were scraped, using a small garden shovel in order to check if the ants were present in the burrow's interior. The behaviour of the ground squirrels was observed with binoculars for several minutes before the start of the transects.

Located on the northern slopes of Central Stara Planina mountain, Bulgarka Nature Park occupies 236.9 km^2 with an average altitude of 870 m. Most of the park area (89%) is covered by deciduous forests and only the highest parts, close to the park's borders, are meadows. Ground squirrel colonies have been previously documented there (V. Popov – personal data for 2003, Koshev 2013). In 2013, the park's directorate started a reintroduction programme in one such locality - Karamandra (42.7410N; 25.2510E, 1410 m a.s.l.). For the next three years, 149 animals were translocated there (Koshev et al. 2019).

The Vrachanski Balkan Nature Park is located in western Bulgaria, in the Stara Planina mountain. Its area is 288.03 km^2 and the average altitude is 700 m (Bechev and Georgiev 2016). The species disappeared at the end of the 1950s due to a ban on transhumance (G. Stoyanov - unpubl. record). In 2013, park's authorities started a ground squirrel reintroduction project near Parshevitsa hut (43.1379 N; 23.4855 E, 1420 m a.s.l.) where there were historical data of its presence in the past. Until 2016, 132 individuals in total were translocated in order to form a new colony (Koshev et al. 2019).

The habitat in both locations is similar - mesophyte mountain meadows with diverse vegetation including both dicotyledonous and monocotyledonous plants. It is on a southern slope with a limestone base. A common species covering most of the ant nests is the *Thymus* sp. A moderate level of livestock grazing occurs (cattle in Bulgarka and horses in Vrachanski Balkan).

Results

In **Bulgarka** Nature Park, 82.3% of all 132 burrows mapped were at the base of ant mounds (Fig. 1a, b). The most abundant ant species was *Lasius flavus* (65% active *L. flavus* nests of all nests with burrows) (Table 1). The rest of the nests with burrows were probably also built by the yellow meadow ant but currently abandoned - empty or occupied by other ant species. There was usually one (95%) and rarely two holes at one nest (Table 1). Nests of *Formica pratensis* were also observed, but there were no souslik burrows in the immediate vicinity. The area where the colony was detected in 2017 is 750 m distant from the release site and is densely covered with *Lasius flavus* nests. On the release site, only two ant nests were found.

Table 1.

Types of ant nests with burrows mapped in 2019.

	Bulgarka Nature Park	**Vrachanski Balkan Nature Park**
Total number of burrows mapped	**132**	**84**
Transect length	**5043 m**	**4398 m**
Percentage of burrows in ant nests by ant species:		
Lasius flavus nests	64.7%	57.1%
Formica cunicularia nests	-	1.2%
Formica rufibarbis nests	-	1.2%
Abandoned or very old nests (more than 10 years) of *L. flavus* occupied by *Lasius alienus*	-	6%
Abandoned or very old nests (more than 10 years) of *L. flavus* occupied by *Formica fusca*	-	3.5%
Abandoned or very old nests (more than 10 years) of *L. flavus* occupied by *Myrmica scabrinodis*	2.9%	-
Abandoned or very old nests (more than 10 years) of *L. flavus* occupied by *Tetramorium* sp.	2.9%	-
Nests of Lasius flavus where it was found coexisting with *Myrmica scabrinodis*	1.5%	-
Nests of Lasius flavus where it was found coexisting *with Tetramorium* sp.	1.5%	-
Empty nests	8.8%	1.2%
Total percentage of burrows in ant nests	**82.3%**	**70.2%**
Ant nests with one hole	95%	97%
Ant nests with two or three holes	5%	3%